

# State Buildings Energy Efficiency: Learn How to Save Energy in State Buildings

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Sponsored by:

Alabama Department of Economic and Community Affairs –  
Science, Technology, and Energy Division;

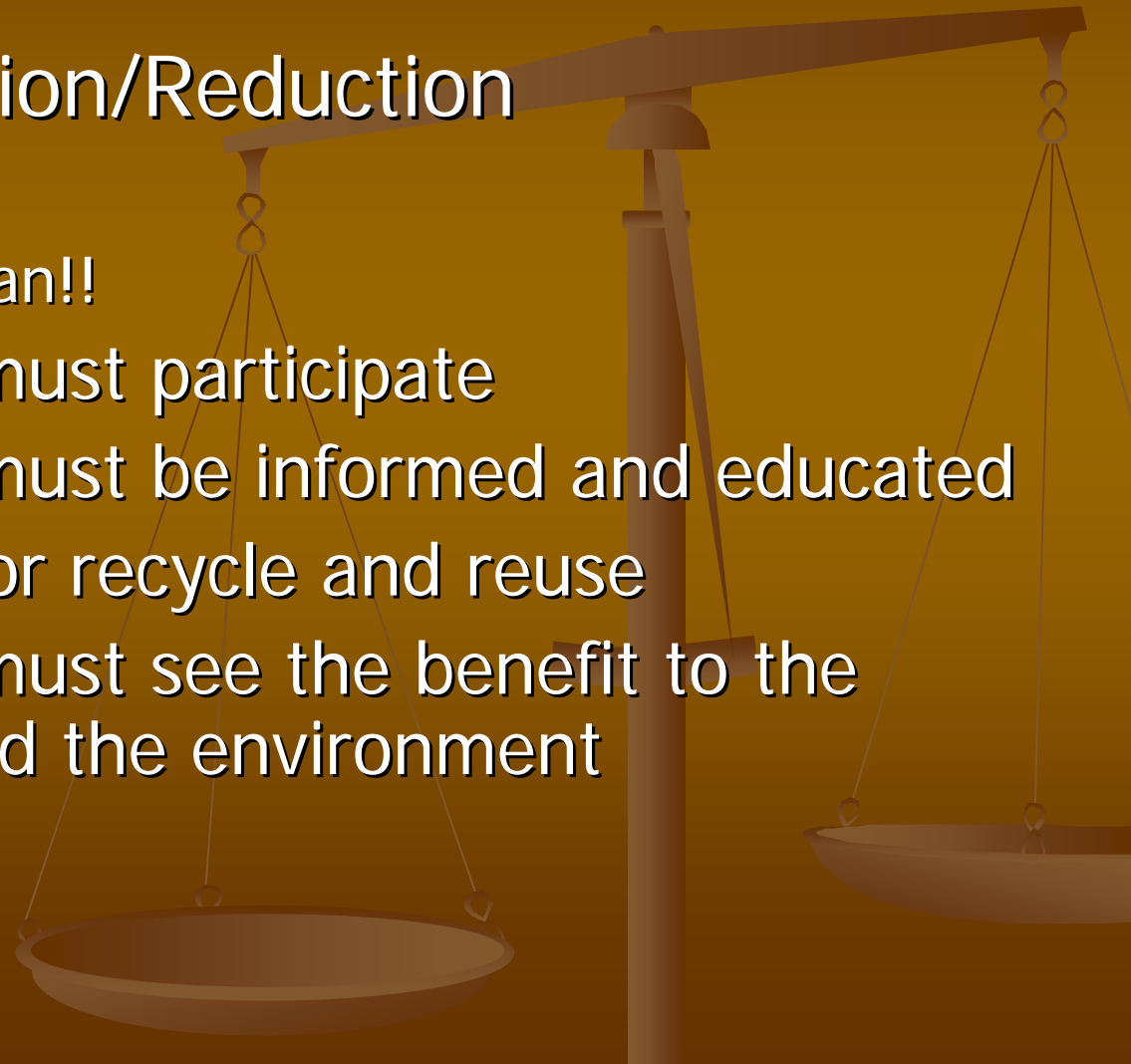
and the

Alabama Department of Finance

# Introduction

## Energy Conservation/Reduction

- State of Mind
  - Must have a plan!!
- All employees must participate
- All employees must be informed and educated
- Opportunities for recycle and reuse
- All employees must see the benefit to the organization and the environment



# Procurements at Your Facility

- What are utility costs?

- Electricity
- Natural Gas
- Propane
- Water
  - Sewage Disposal

- Gather Facility Data



# Where Do I Look to Save Energy at My Facility?

- Electricity
  - Heating, Ventilating, and Air Conditioning (HVAC)
    - Accounts for approximately 40 – 60 percent of total consumption
  - Lighting Systems
    - Accounts for approximately 20 – 30 percent of total consumption for electricity
  - Other Electrical Equipment
    - Accounts for approximately 20 – 30 percent of total consumption

Reference: Lam *et al.* [2004]

# Where Do I Look to Save Energy at My Facility? (con't.)

- Natural Gas or Propane
  - HVAC systems
  - Hot water systems
- Water
  - Plumbing Fixtures
    - Low water use fixtures
  - Irrigation Systems
  - Sewer Systems
    - Onsite sewage disposal vs. sanitary sewer



# Gather Facility Data

- Determine the areas of greatest need and the most cost-effective energy-saving opportunities
- Evaluate buildings
  - Energy Star's national energy performance rating system
  - Private Contractor – Energy Performance Contracting

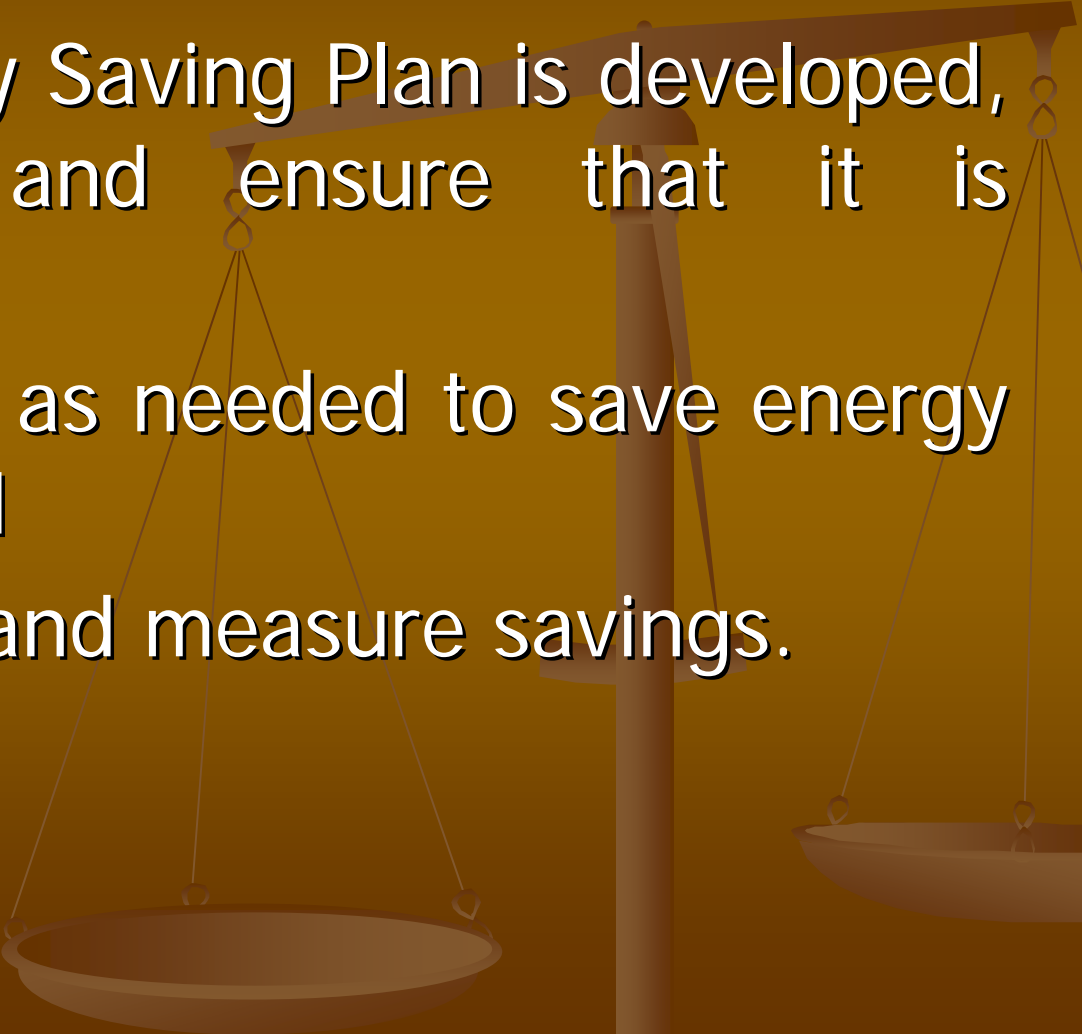
Reference: Local Government Guide

# Develop a Plan

- Appoint a coordinator to lead a team at your facility to implement an Energy Conservation Program
  - Define targets, objectives and quantifiable goals
  - Inform all employees of the goals and objectives of the program
    - Present the numbers and show potential savings/benefit
  - Hire a consultant to perform audits if needed
    - Energy Performance Contracting
  - Show how energy saving methods can be carried home to save employees money
  - Research funding options
    - Local utilities
    - State/Federal Agencies

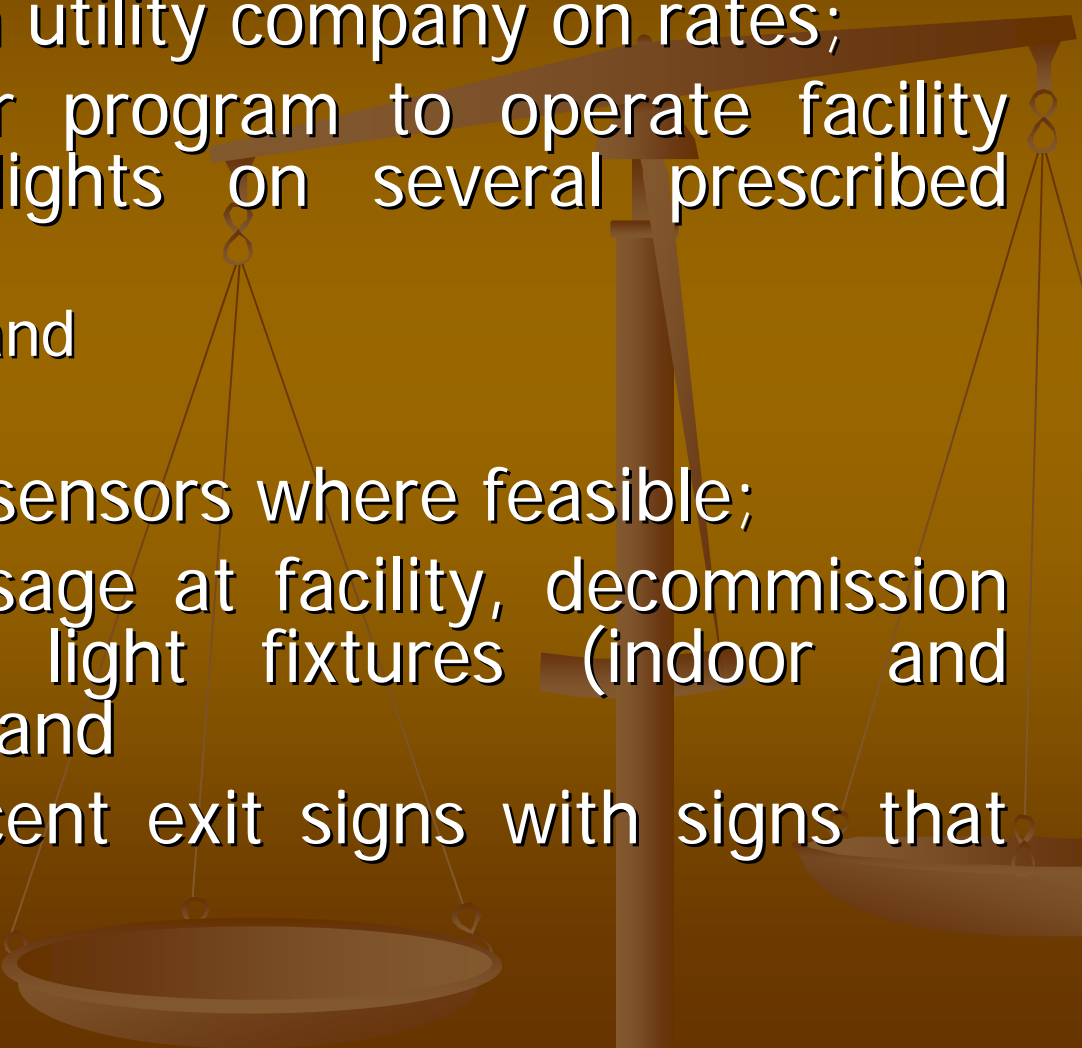
Reference: Local Government Guide

# Implement Program/Operations

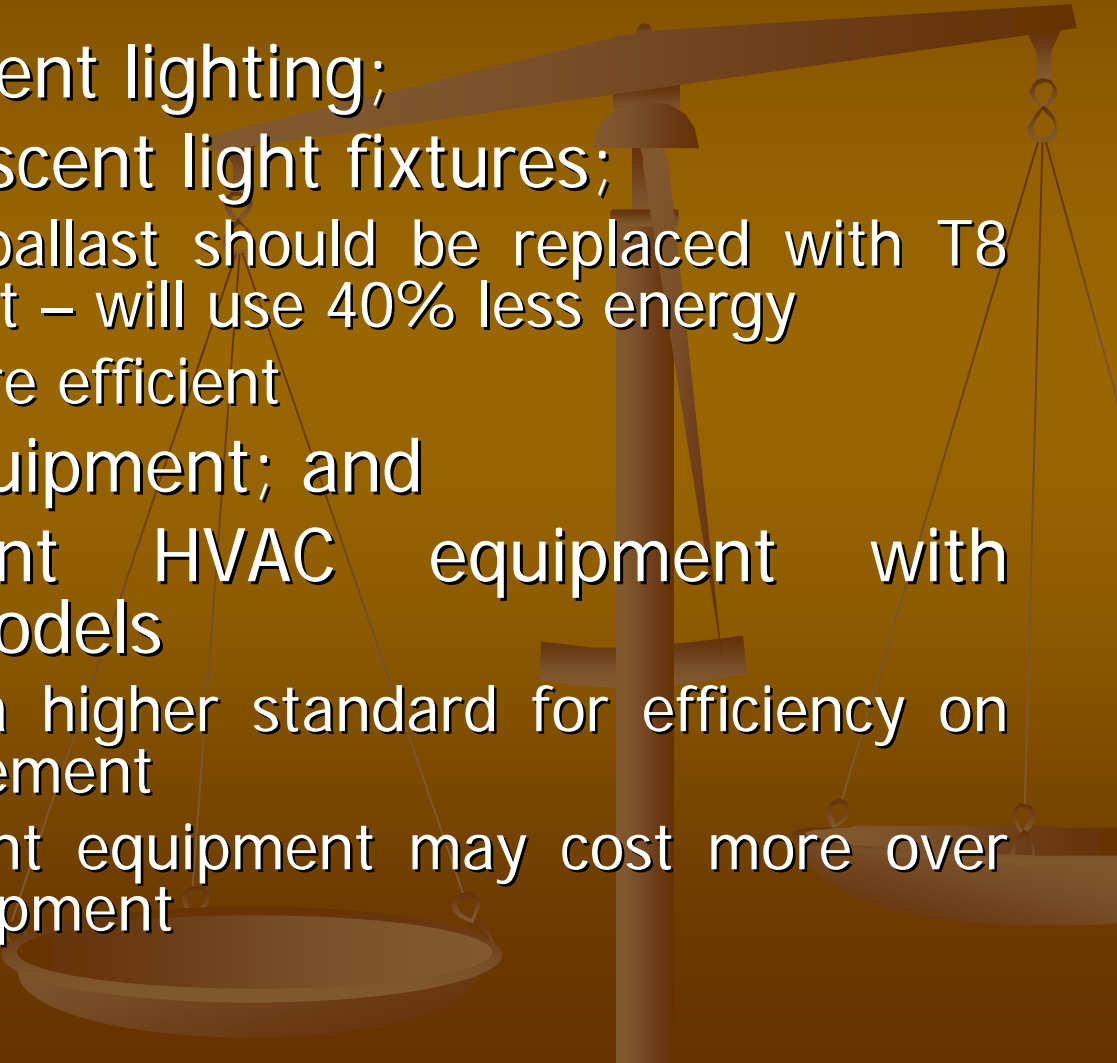
- When an Energy Saving Plan is developed, implement it and ensure that it is followed;
  - Modify the plan as needed to save energy and money; and
  - Monitor results and measure savings.
- 



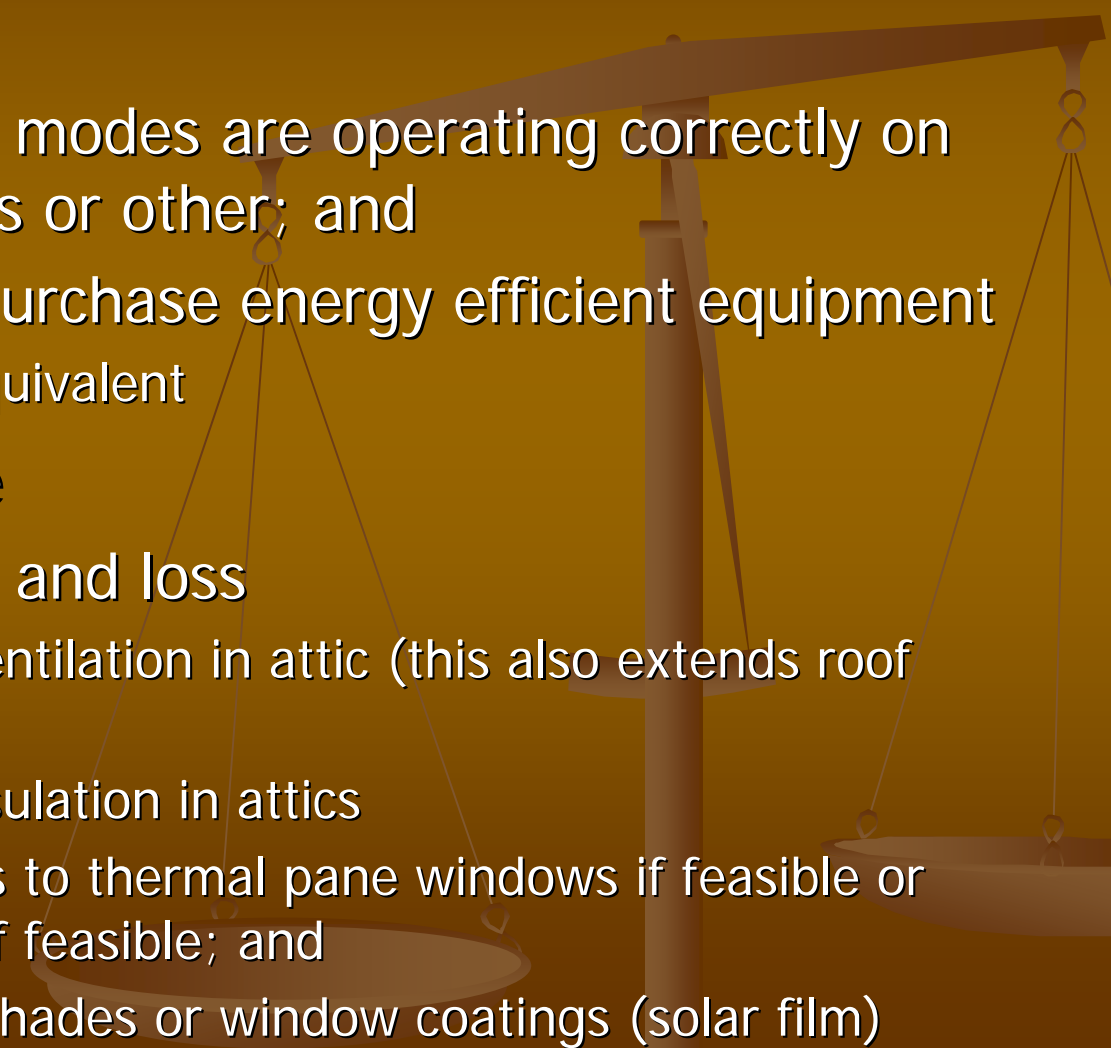
# What can I do to save Electricity?

- Communicate with utility company on rates;
  - Develop computer program to operate facility equipment and lights on several prescribed schedules
    - After hours plan; and
    - Peak usage plan
  - Install occupancy sensors where feasible;
  - Review lighting usage at facility, decommission all non-essential light fixtures (indoor and outdoor fixtures); and
  - Replace incandescent exit signs with signs that use LED lamps
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# What can I do to save Electricity? (cont'd.)

- Replace incandescent lighting;
  - Replace old fluorescent light fixtures;
    - T12 w/magnetic ballast should be replaced with T8 w/electronic ballast – will use 40% less energy
    - T5 bulbs even more efficient
  - Maintain HVAC equipment; and
  - Replace inefficient HVAC equipment with energy-efficient models
    - Consider setting a higher standard for efficiency on equipment procurement
    - Low cost inefficient equipment may cost more over the life of the equipment
- 

# What can I do to save Electricity? (cont'd.)

- Office Equipment
    - Ensure that sleep modes are operating correctly on computers/copiers or other; and
    - Create policy to purchase energy efficient equipment
      - Energy Star or equivalent
  - Building Envelope
    - Reduce heat gain and loss
      - Provide proper ventilation in attic (this also extends roof surfacing life);
      - Ensure proper insulation in attics
      - Upgrade windows to thermal pane windows if feasible or provide shading if feasible; and
      - Provide window shades or window coatings (solar film)
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# Building Envelope

- Insulate glazing, walls, ceilings, and roofs;
- Close holes and openings in building (such as broken windows);
- Increase insulation thickness; and
- Use proper thickness of insulation on building envelope

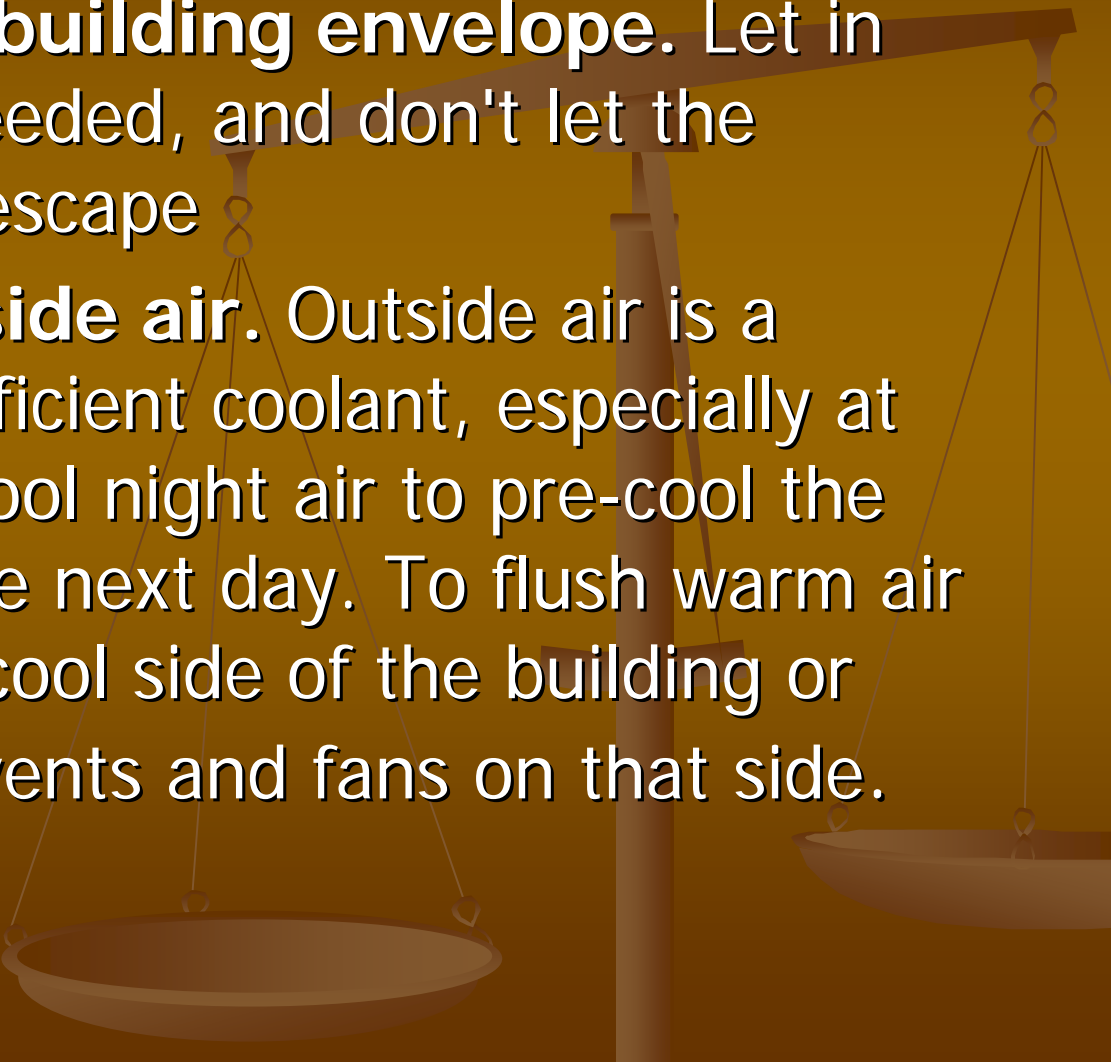
Reference: IAC Recommendation Database

<http://iac.rutgers.edu/database/recommendations.php?D1=0&D2=0&D3b=%3E%3D&D3=0&D4b=%3E%3D&D4=0&state=0&D5=0&D6=building+envelope>

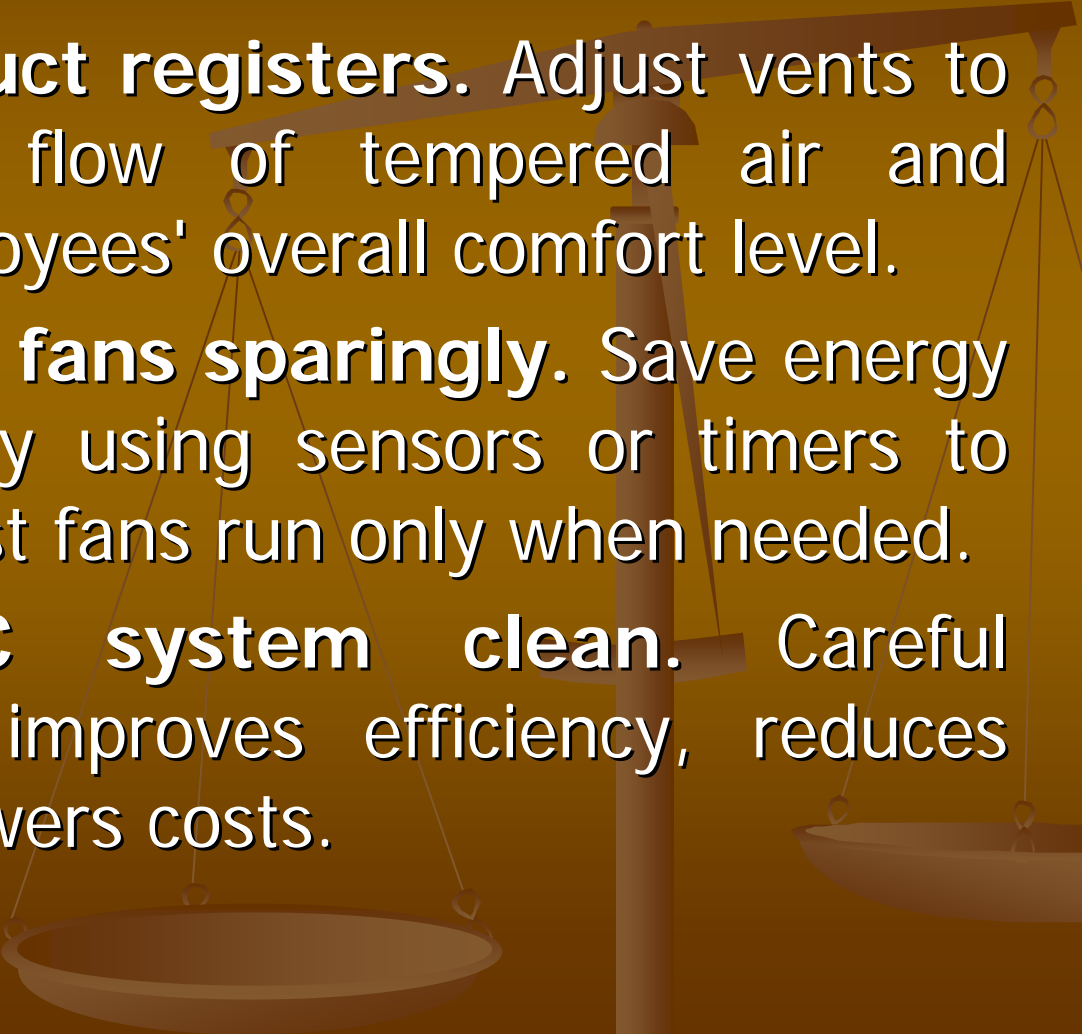
# HVAC and Building Envelope

- HVAC system can account for up to 30% of energy usage. So it pays to improve its efficiency.
- Simple ways to cut system's operating cost.
  1. **Turn it off.** Experiment to determine how long it takes for space to heat up or cool down. Time the thermostat to turn on shortly before occupants arrive and to shut off one half-hour before they leave, so it keeps the space temperate only when it's full of employees. Saves money by only using the HVAC system when needed.

# HVAC and Building Envelope

2. **Manage the building envelope.** Let in only the air needed, and don't let the tempered air escape
  3. **Draw in outside air.** Outside air is a natural and efficient coolant, especially at night. Let in cool night air to pre-cool the building for the next day. To flush warm air out, vent the cool side of the building or operate attic vents and fans on that side.
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# HVAC and Building Envelope

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4. **Adjust air duct registers.** Adjust vents to manage the flow of tempered air and increase employees' overall comfort level.
  5. **Use exhaust fans sparingly.** Save energy and money by using sensors or timers to ensure exhaust fans run only when needed.
  6. **Keep HVAC system clean.** Careful maintenance improves efficiency, reduces waste, and lowers costs.

# HVAC and Building Envelope

- Reduce heat conductivity. Some building materials, such as single-pane glass or metals, are better at conducting heat than others. Use materials with a high R Value (resistance to heat conductivity) wherever possible for better insulation. The R-value is the measure of a substance's resistance to heat conduction. Insulate walls to make them less heat-conductive.



# HVAC and Building Envelope

- Insulation thickens a building's envelope and makes it easier and less expensive to control its climate year-round. It reduces heating bills in the winter and cuts air conditioning cost in summer.
- Weatherization – filling leaks and gaps in windows, doors, and walls -- is a great way to strengthen your building envelope. Moderation is the key to successful weatherization. Use the following tips to focus your efforts:
  - **Weather strip doors.** The 1/4" gap between a pair of exterior doors can add up to 20 square inches.

# HVAC and Building Envelope

- **Weather strip windows.** Small gaps in window sashes can create big energy losses.
- **Adjust automatic door settings.** Set automatic door closers to open and close as rapidly as is reasonable and safe.
- **Seal unused window air conditioners.** To keep air from leaking in and out, cover the exterior of window air conditioners when they are not in use.
- **Seal major cracks.** Weatherize windows and exterior doors by filling cracks and repairing other gaps where climate-controlled air can escape.

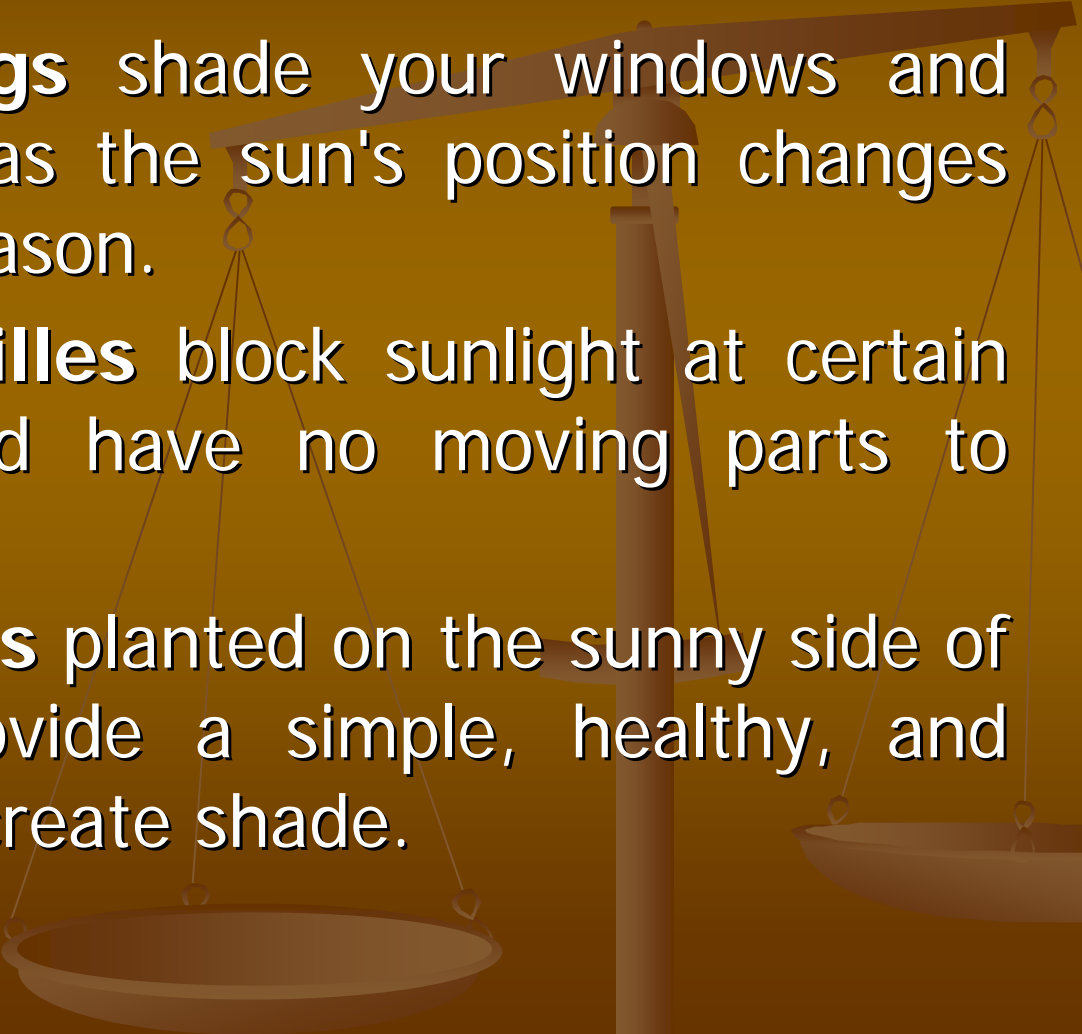
# HVAC and Building Envelope

- Consider the following window improvements:
  - **Double-paned "low emissivity" windows.** These windows are currently the standard in most buildings. They insulate nearly as well as triple-pane glass but cost less.
  - **High R-value windows.** Older windows have an R-value of 0.9, but windows have ratings as high as 8
  - **Recessed windows.** Sometimes called "brise soleils," these windows provide shade at certain times of day. Note: For best results, recessed windows need to be included in the original design of the building.

# HVAC and Building Envelope

- **Coating your window with a film of reflective material** (sometimes called solar film) prevents unwanted heat and glare.
- **Storm windows** are installed over original windows to create an insulating layer of air. "Triple track" storm windows with screens are available for windows that need to open more frequently.

# HVAC and Building Envelope

- **Movable awnings** shade your windows and can be adjusted as the sun's position changes from season to season.
  - **Fixed lattice grilles** block sunlight at certain times of day and have no moving parts to replace.
  - **Green leafy trees** planted on the sunny side of your building provide a simple, healthy, and attractive way to create shade.
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# Heating Ventilating and Air Conditioning

- Managing separate systems for heating and air conditioning can be complicated and costly. Electric heat pumps solve these problems by cooling and heating – even water heating – with a single system.
- Heat pumps are:
  - **Efficient.** They are three to four times more efficient than other HVAC systems.
  - **Dependable.** Because the technology has been thoroughly tried and tested, manufacturers offer substantial service agreements and warranties.

# Heating Ventilating and Air Conditioning

- **Clean.** They release no emissions or toxic byproducts into the atmosphere.
- **Durable.** New compressors last a very long time.
- **Safe.** Unlike gas boilers, they use no combustion flame.
- **Quiet.** They run far more quietly than comparable gas combustion machines.
- **Intelligent.** They heat air to a more moderate temperature when it's distributed, losing less heat in ductwork and minimizing room air stratification.

# Heating Ventilating and Air Conditioning

- The most common commercial cooling system throughout the State of Alabama employs the chillers.
- If the building requires a large amount of cool air to keep it comfortable, a chiller is a good air conditioning option.
- A chiller uses an electric refrigeration machine to cool (chill) water, circulates the water through one or more coils to cool air, and vents the cooled air through the building. Chillers are reliable, cost-effective, and easy to customize.



# Heating Ventilating and Air Conditioning (HVAC)

- HVAC maintenance
  - **Dirt makes HVAC equipment work harder.** Heat pumps, air conditioners, and chillers all function by transferring heat. The transfer surfaces work best when they're free of grime, dust, or other obstructions. Cleaning HVAC equipment and replacing dirty filters will save energy and lower costs.
  - **Small adjustments can yield big savings.** You can create substantial savings by turning up the thermostat of your air-cooling device just 2-3°F or by adjusting the automated settings of your heat pump's supplementary electric-resistance heating elements

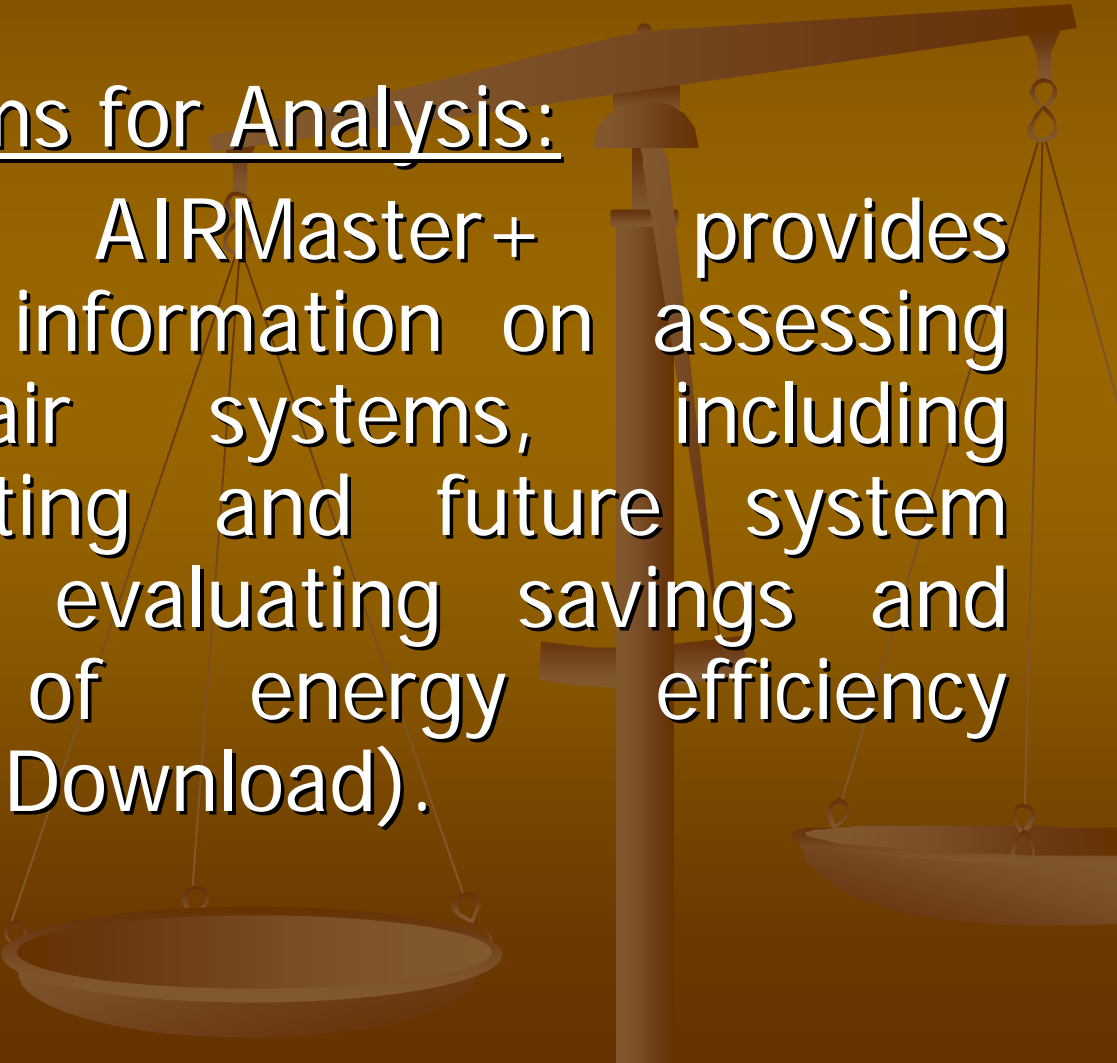
# Heating Ventilating and Air Conditioning (HVAC)

- **Check refrigerant levels.** The sealed subsystems filled with refrigerant in your chillers, heat pumps, and air conditioners should be checked for leaks and level drop-offs.
- **Check fan speeds.** They can function adequately and run more efficiently when set at a low level.
- **Adjust belt drives.** Set them to run fans at the lowest reasonable level and tighten them so they don't slip.
- **Inspect all parts.** Check valves, dampers, linkages, and motors. Repair, recalibrate, or replace controls. Check and maintain steam traps, vacuum systems, and vents in two-pipe steam systems.
- **Make seasonal adjustments.** Turn off water pumps in hot water heating systems in mild weather.

# Heating Ventilating and Air Conditioning

## Computer Programs for Analysis:

AIRMaster+ - AIRMaster+ provides comprehensive information on assessing compressed air systems, including modeling, existing and future system upgrades, and evaluating savings and effectiveness of energy efficiency measures (Free Download).



# Heating Ventilating and Air Conditioning

Chilled Water System Analysis Tool (CWSAT)  
Version 2.0 - Use the Chilled Water System Analysis Tool (CWSAT) to determine energy requirements of your system, and to evaluate opportunities for energy and costs savings by applying improvement measures. Provide basic information about an existing configuration to calculate current energy consumption, and then select proposed equipment or operational changes for comparison. The results of this analysis will help you quantify the potential benefits of chilled water system improvements (Free Download).

# Heating Ventilating and Air Conditioning

Combined Heat and Power Application Tool (CHP) - The Combined Heat and Power (CHP) Application Tool helps industrial users evaluate the feasibility of CHP for heating systems such as fuel-fired furnaces, boilers, ovens, heaters, and heat exchangers. It allows analysis of three typical system types: fluid heating, exhaust-gas heat recovery, and duct burner systems. Use the tool to estimate system costs and payback period, and to perform "what-if" analysis for various utility costs. The tool includes performance data and preliminary cost information for many commercially available gas turbines and default values that can be adapted to meet specific application requirements (Free Download).

# Heating Ventilating and Air Conditioning

Fan System Assessment Tool (FSAT) - Use the Fan System Assessment Tool (FSAT) to help quantify the potential benefits of optimizing fan system configurations that serve industrial processes. FSAT is simple and quick, and requires only basic information about your fans and the motors that drive them. With FSAT, calculate the amount of energy used by your fan system; determine system efficiency; and quantify the savings potential of an upgraded system (Free Download).

Reference: (Dept. of Energy Website):

[http://www.oit.doe.gov/bestpractices/software\\_tools.shtml#air](http://www.oit.doe.gov/bestpractices/software_tools.shtml#air))



# Heating Ventilating and Air Conditioning

## “Surface Temperature” Case Study:

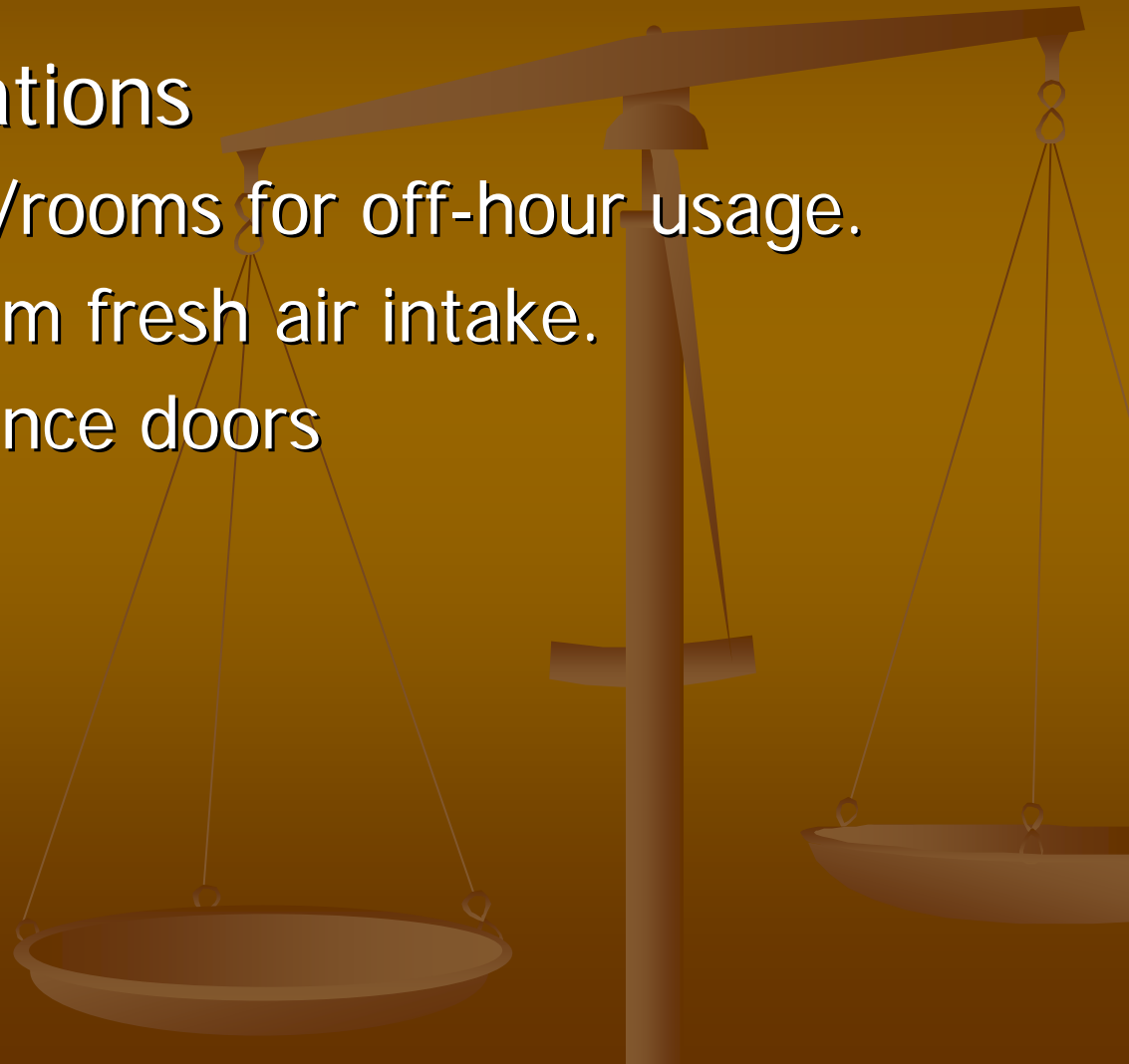
“The easiest way to help cut heat loss and heat gain are to install blinds that have louvers. The louvers will allow the light to come in while keeping out solar gain and keeping in most of the heat.”

Reference:

[http://www.aa.uidaho.edu/archwebs/bldgvi  
tal/psb4c.html](http://www.aa.uidaho.edu/archwebs/bldgvi<br/>tal/psb4c.html)

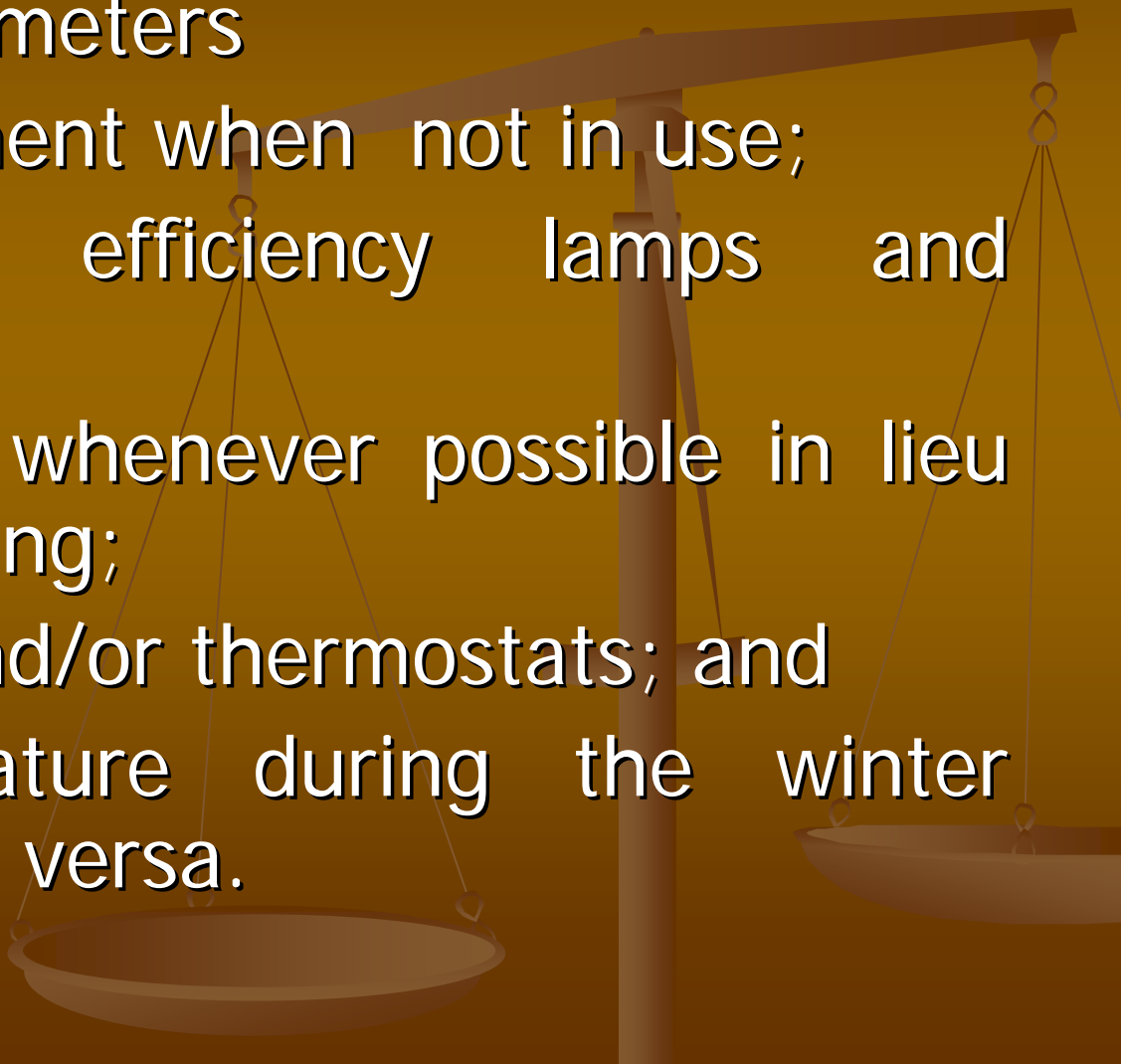
# Heating Ventilating and Air Conditioning

- Other Considerations
  - Individual units/rooms for off-hour usage.
  - CO<sub>2</sub> levels to trim fresh air intake.
  - Revolving entrance doors





# Power

- Combine utility meters
  - Turn off equipment when not in use;
  - Utilize higher efficiency lamps and ballasts;
  - Utilize daylight whenever possible in lieu of artificial lighting;
  - Install timers and/or thermostats; and
  - Lower temperature during the winter season and vice versa.
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# Power (cont'd.)

- Demand evaluation study
  - For example, multiple chillers
- Modify storage space to avoid rental of a warehouse; and
- Install timers on light switches in little used areas

**Reference: IAC Recommendation Database**

<http://iac.rutgers.edu/database/recommendations.php?D1=0&D2=0&D3b=%3E%3D&D3=0&D4b=%3E%3D&D4=0&state=AL&D5=0&D6=Power>

# Lighting

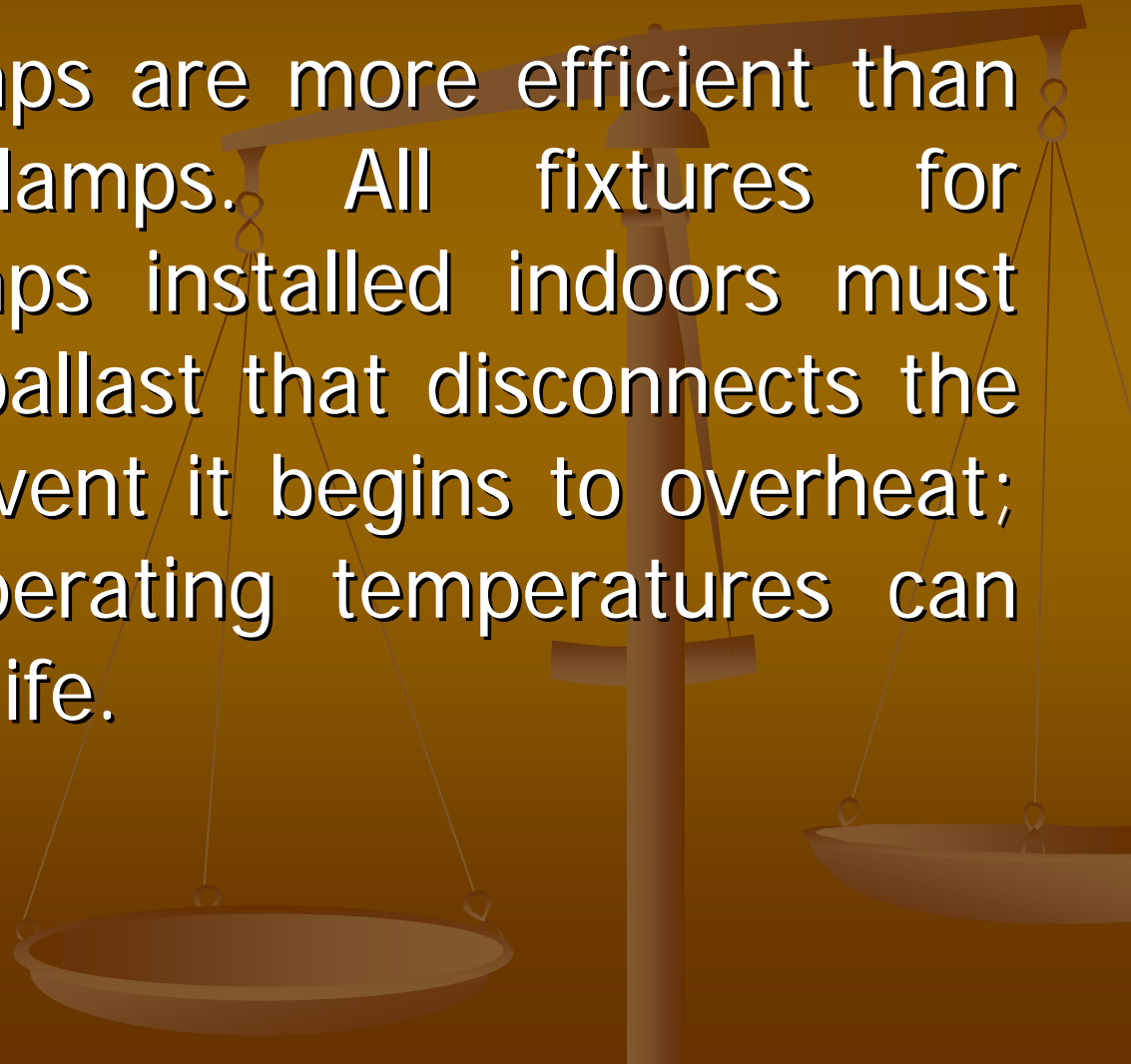
- Lighting system can reduce energy in 2 ways: reducing the lighting system's input wattage (W or kWh) or reducing its hours of operation.
- Input wattage can be reduced by replacing lamps and ballasts with more-energy-efficient counterparts or outright removal of lamps and ballasts.
- The hours of operation can be reduced using sophisticated controls and other methods.

# Lighting

- Lighting systems convert only a minor fraction of their electrical input into useful light output. Much of the rest is released directly as heat into the space. Therefore, any upgrade of the lighting system that reduces input wattage reduces the amount of heat that must be removed by the air cooling system. This results in air cooling energy savings during the operation of the building. In new construction, an energy-efficient lighting design can result in significant savings in the installed cost of cooling systems.

# Lighting

- Fluorescent lamps are more efficient than incandescent lamps. All fixtures for fluorescent lamps installed indoors must use a Class P ballast that disconnects the ballast in the event it begins to overheat; high ballast operating temperatures can shorten ballast life.



# Lighting

- Linear fluorescent lamps often are less expensive than compact fluorescent lamps. They can also produce more light, are easier to dim, and last longer.
- Cold cathode fluorescent lamps are one of the latest technological advances in fluorescent technology. The "cold" in cold cathode means there is no heating filament in the lamp to heat up the gas. This makes them more efficient. Also, since there's no filament to break, they're ideal for use in rough service environments where a regular lamp may fail. They are often used as backlights in LCD monitor. They are used in exit signs too.

# Lighting

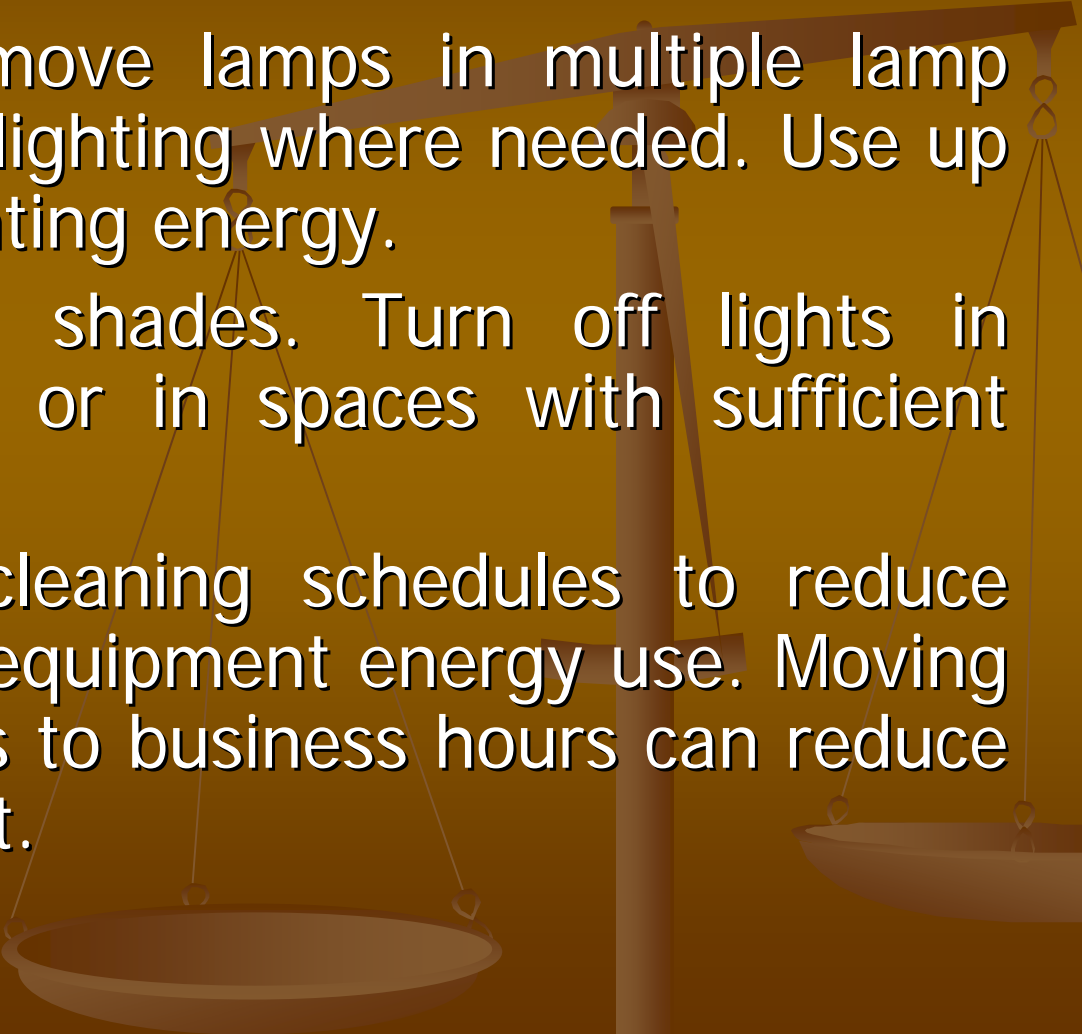
- High Intensity Discharge lamps are typically used when high levels of light are required over large areas and when energy efficiency and/or long life are desired. These areas include gymnasiums, large public areas, warehouses, outdoor activity areas, roadways, parking lots, and pathways.
- Occupant Sensors are useful in reducing costs, increasing control intelligence, and improving ability to detect minor motion .

# Lighting

- Low-pressure sodium lamps are used where color rendition is not important but energy efficiency is. They are commonly used for outdoors, roadways, parking lots, and pathway lighting.
- Light emitting diodes can be used for exit signs as they are more energy efficient
- Electronic ballasts are more energy efficient than magnetic ballasts. These electronic ballasts experience half the power loss of magnetic ballasts. They are also quieter, lighter and they virtually eliminate lamp flicker.
- Make sure you are getting the best possible light by cleaning fixtures and replacing any yellow or hazy lenses and diffusers twice a year.



# Lighting

- Disconnect or remove lamps in multiple lamp fixtures. Use task lighting where needed. Use up to 50% less in lighting energy.
  - Open blinds and shades. Turn off lights in unoccupied areas or in spaces with sufficient natural lighting.
  - Adjust janitorial cleaning schedules to reduce total lighting and equipment energy use. Moving cleaning schedules to business hours can reduce overall energy cost.
- 

# Lighting

- Use teamwork to reduce lighting loads. Cleaning staff can work in teams (instead of different areas simultaneously) to reduce lighting usage. This can save up to 20% in lighting energy.
- Buy fixtures that have a dimmer, which allows manual adjustment of the intensity of light in a room. Because most lights use less electricity at lower settings, there is no need to pay for more light than needed. Dimmers can be used with incandescent lights, including low-voltage systems, but only with new-screw-based dimmable fluorescent bulbs. Other fluorescent lights must have their own dimmable ballasts.

# Lighting

- Install motion sensors outdoors. Use timers and sensors on outdoor lights to avoid leaving the lights on during nighttime hours.
- Replace incandescent light bulbs with compact fluorescent lamps (CFLs), wherever appropriate. CFLs use at least 66% less energy and last an average of 10 times longer.
- Convert T12s and magnetic ballasts to T8 lamps and electronic ballasts. T8 lamps produce more light per watt of energy input than T12s and can reduce energy by 40%; consider use of T5 lamps.

# Lighting

- Install occupancy sensors in the proper locations to automatically turn off lighting when no one is present, and back on when they return. Use sensors in rooms with high traffic (break rooms, restrooms, conference rooms) for reduced lighting costs of up to 40%. Don't install the sensor behind a coat rack, door or book case. It must be able to "see" the motion of occupant approaching an unlit area to turn on the light before, or as they enter.
- Retrofit hallway and security lighting. Convert hallway and non-public security lighting to energy saving 25-Watt T12 bulbs.
- Rewire restroom fans to operate when lights are turned on and turn off when the restroom is unoccupied.

# Lighting

- Install exit signs with Light Emitting Diodes (LED). A new LED exit sign fixture will save about 90% over an incandescent bulb's operating costs.
- Replace standard fluorescents. T8s and matched electronic ballasts provide an estimated savings of 35 to 45% of electricity operating costs.
- Install energy management system (EMS) technology to control lighting systems automatically. Energy savings can range from 10 to 15% of total lighting energy use.

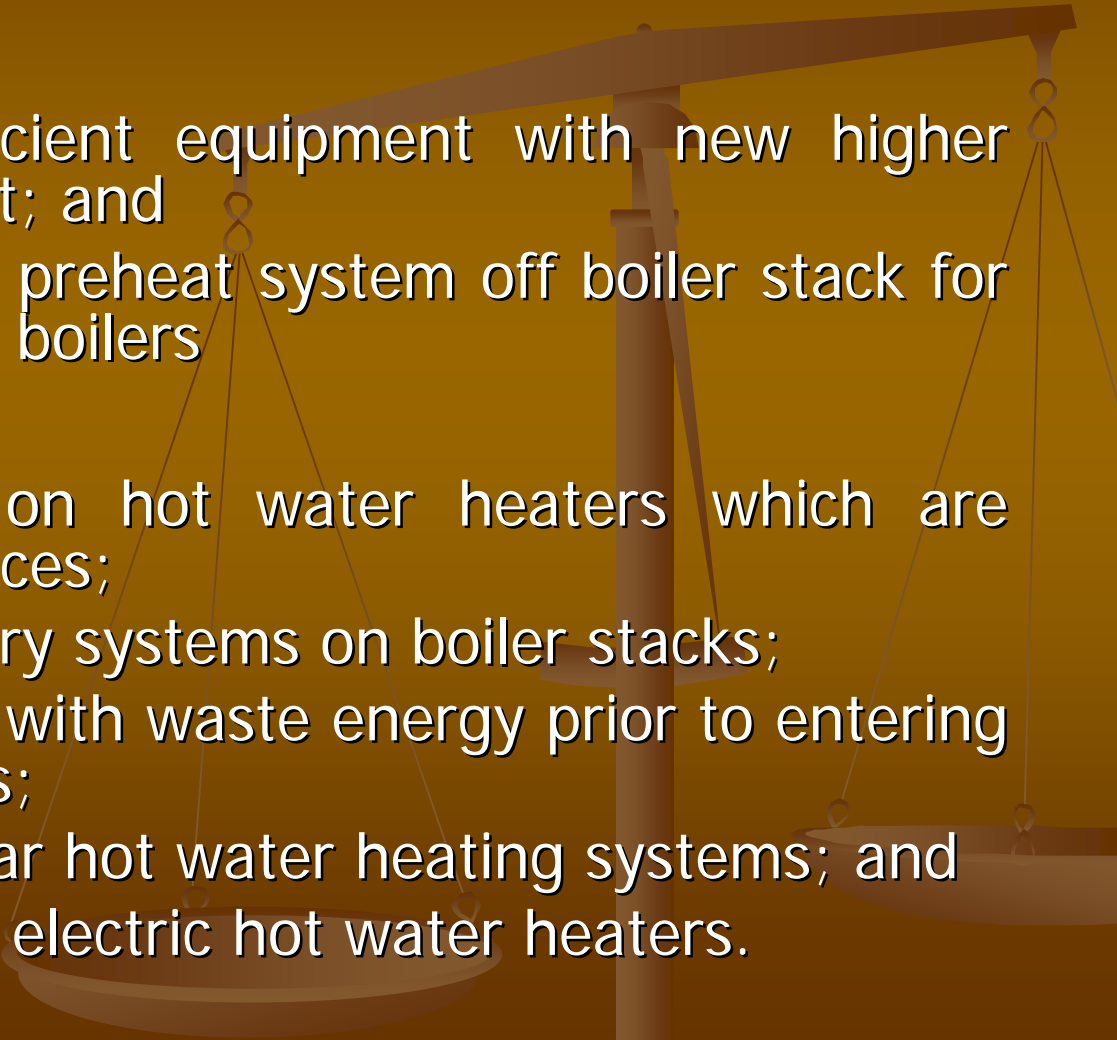
# Lighting

- Improve fluorescent lighting efficiency;
- Install lower wattage lighting;
- Install high efficiency lighting;
- Cease lighting outside areas during daytime hours;
- Reduce lighting in bright areas;
- Install timer(s) on outside lighting; and
- Install lighting motion sensors in the staging and shipping areas.

Source: IAC Recommendation Database

<http://iac.rutgers.edu/database/recommendations.php?D1=0&D2=0&D3b=%3E%3D&D3=0&D4b=%3E%3D&D4=0&state=AL&D5=0&D6=Lighting&B1=Submit>

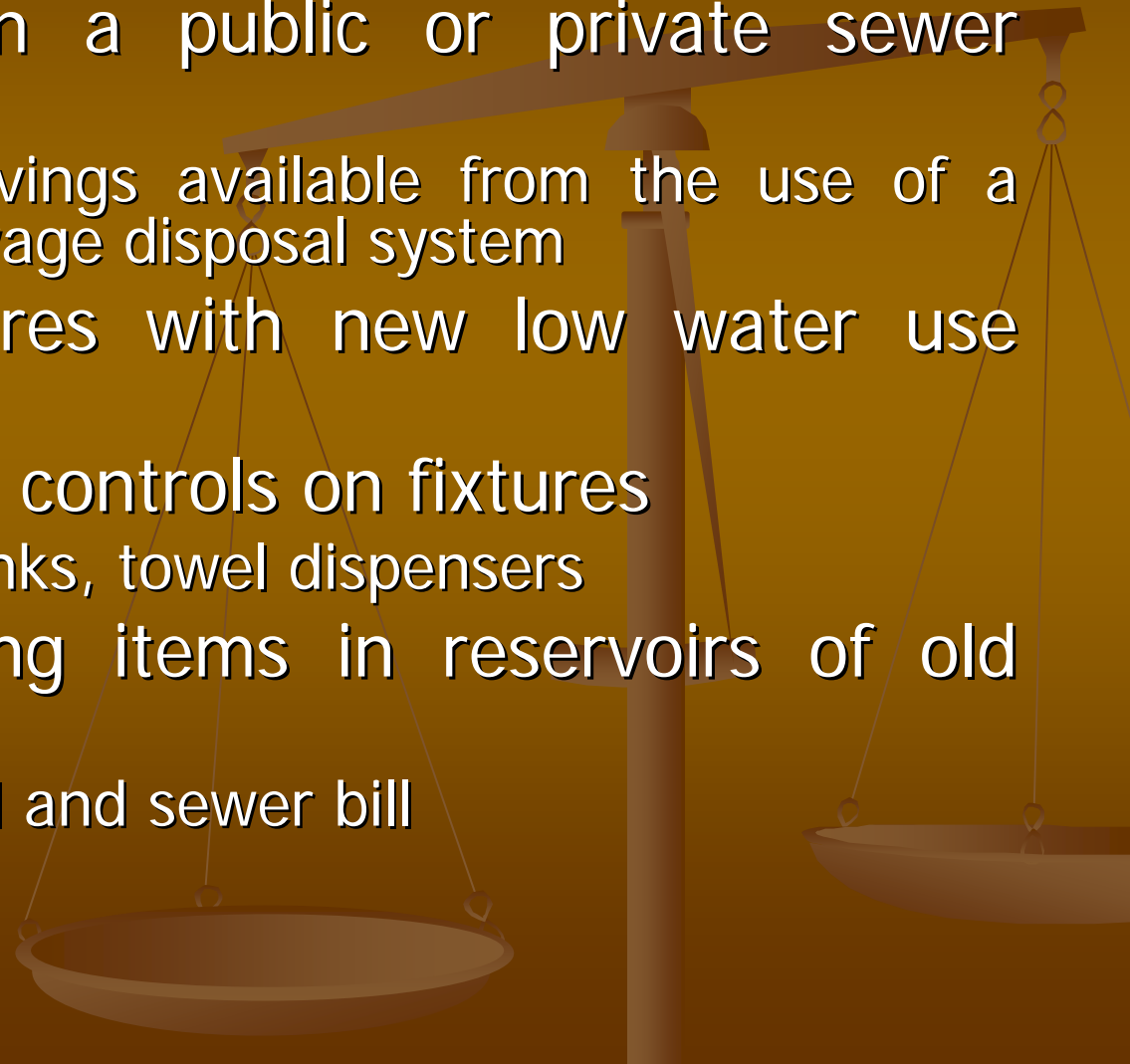
# What can I do to save Natural Gas or Propane?

- Heating System
    - Replace old inefficient equipment with new higher efficient equipment; and
    - Install economizer preheat system off boiler stack for make up water for boilers
  - Hot Water System
    - Provide blankets on hot water heaters which are located in cool spaces;
    - Install heat recovery systems on boiler stacks;
    - Preheat hot water with waste energy prior to entering the hot water units;
    - Consider using solar hot water heating systems; and
    - Use “point-of-use” electric hot water heaters.
- 



# What can I do to save water?

- Is the facility on a public or private sewer system?
  - May be costs savings available from the use of a private onsite sewage disposal system
- Replace old fixtures with new low water use fixtures
- Provide automatic controls on fixtures
  - Toilets, urinals, sinks, towel dispensers
- Place water saving items in reservoirs of old toilets
  - Reduces water bill and sewer bill





# Service Water Heating

- Consider natural gas for water heating; and
- Change energy source for water heating (gas to solar)

Reference: IAC Recommendation Database

<http://iac.rutgers.edu/database/recommendations.php?D1=0&D2=0&D3b=%3E%3D&D3=0&D4b=%3E%3D&D4=0&state=0&D5=0&D6=Service+Water+Heating>

# No-Cost/Low-Cost Energy Conservation Measures

- Below is a collection of simple energy conservation measures. All can be accomplished with minimum effort and if practiced, will lead to institutionalized permanent savings.

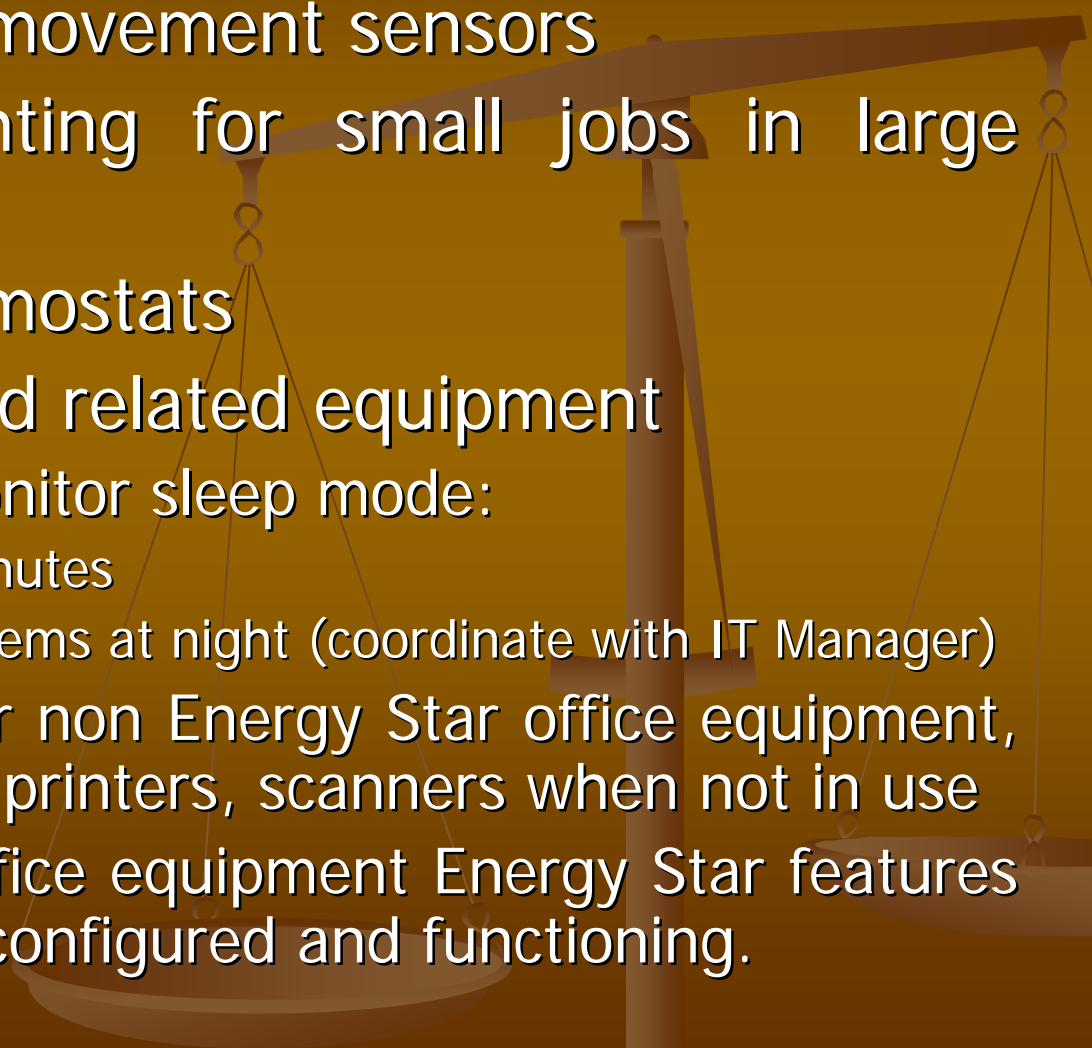
## 1. Compact fluorescent light (CFL) bulbs versus incandescent bulbs (ICB)

- 4 times the energy efficiency
- 5 times the life resulting in reduced maintenance (change out)
- Typical payback period ~1 year. A 27-watt CFL bulb replacing 100-watt ICB saves \$62.90 over the life of a CFL bulb.

## 2. High Efficiency Air Conditioning and Heating Systems

- If system must be replaced (due to equipment breakage) prior to energy audit review, then:
  - Move from 60-70% to 92% efficiency
  - Can yield 40% actual savings in annual costs

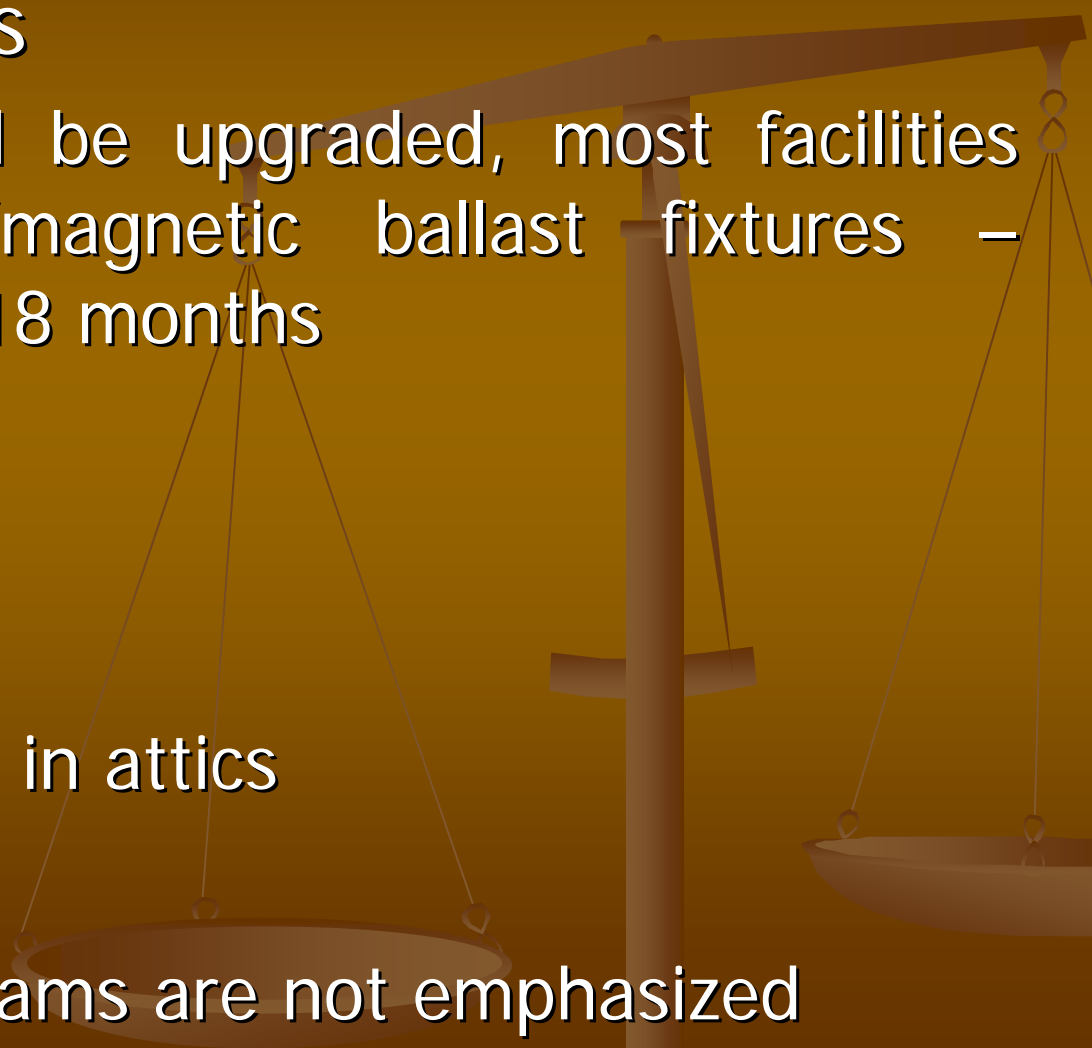
# No-Cost/Low-Cost Energy Conservation Measures

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3. Area lighting movement sensors
  4. Use task lighting for small jobs in large rooms
  5. Set back thermostats
  6. Computers and related equipment
    - a. Computer monitor sleep mode:
      - Set to 30 minutes
      - Turn off systems at night (coordinate with IT Manager)
    - b. Turn off older non Energy Star office equipment, e.g., copiers, printers, scanners when not in use
    - c. Make sure office equipment Energy Star features are properly configured and functioning.

# No-Cost/Low-Cost Energy Conservation Measures

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7. HVAC Filter Change Review Program
    - a. Add pressure differential alarms
    - b. Plugged filters can waste energy and reduce indoor air quality
  8. Hot Water Economizer from HVAC
    - a. Heating season - capture heat from exhaust vent condenser in winter to make hot water
    - b. Air conditioning season - capture A/C condenser heat in summer to make hot water
  9. Landscaping
    - a. Consider "grey water" for lawns

# Experience with Audits of Alabama State Buildings

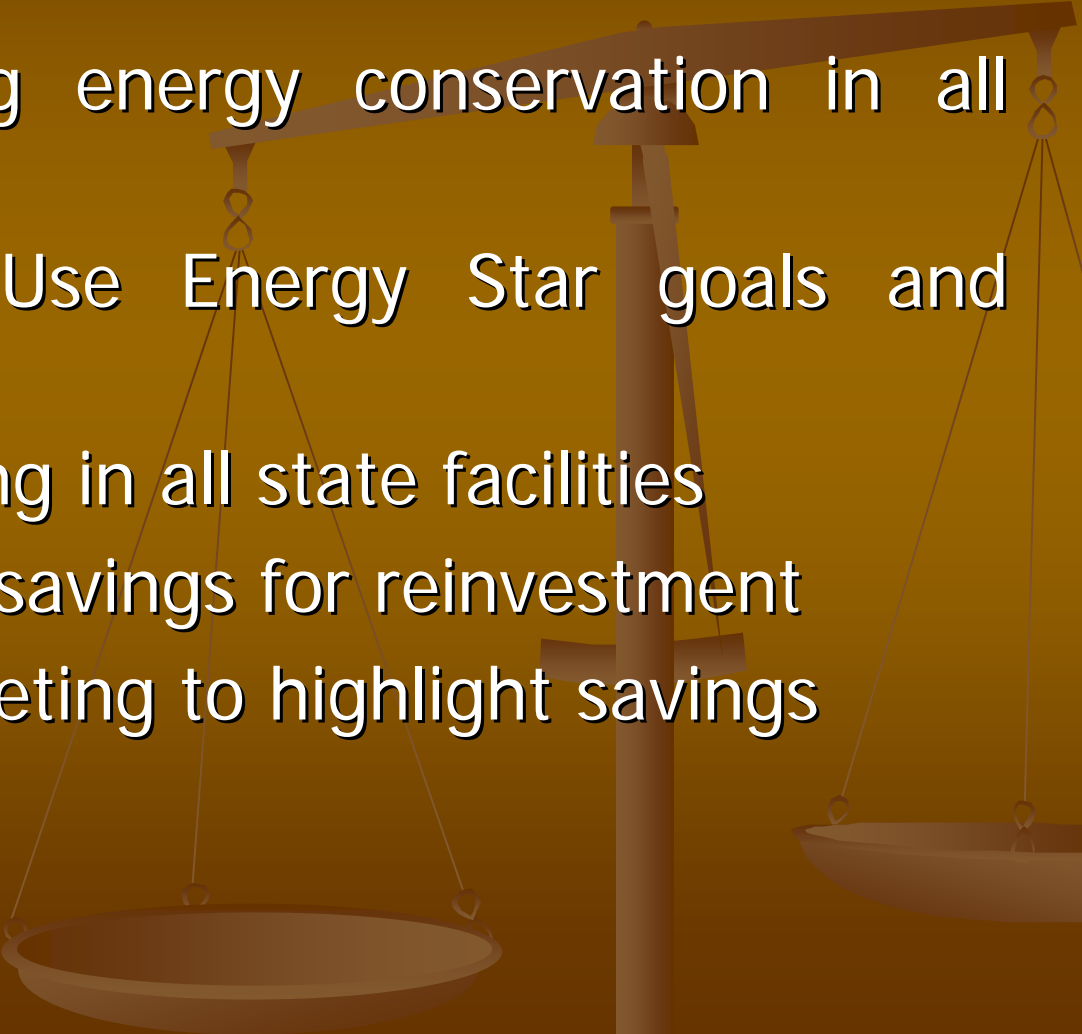
- Quickest savings
    - Lighting should be upgraded, most facilities have T12 w/magnetic ballast fixtures – payback 12 to 18 months
  - Older facilities
    - Old HVAC units
    - Little insulation
    - Poor ventilation in attics
  - Recycling
    - Recycling Programs are not emphasized
- 

# Suggestions

Limited dollars are available for capital improvements.

- Energy Performance Contracting can identify high-payback projects.
- Facilities that do not have the funding or personnel to install and maintain energy saving equipment can contact ADECA to learn more about ENERGY PERFORMANCE CONTRACTING (EPC) at their facility.
- *Develop budget tracking tool to document energy cost savings for reinvestment.*

# Suggestions (cont'd)

- Consider requiring energy conservation in all state facilities
    - For example: Use Energy Star goals and objectives
  - Emphasize recycling in all state facilities
    - Track recycling savings for reinvestment
  - Annual energy meeting to highlight savings
- 

# Suggestions

## Annual state facilities energy meeting

- Highlight lessons learned
- Identify positive performers
- Share ideas across the State
- Use for annual energy budgeting
- Continuous improvement in energy utilization





# Additional Information

- Potential websites to obtain additional information on energy conservation measures:
  - **DOE Energy Matters Newsletter Link:**  
This is an excellent source of info on energy use and auditing with many case studies and data presented.  
[http://www.oit.doe.gov/bestpractices/energymatters/energy\\_matters.shtml](http://www.oit.doe.gov/bestpractices/energymatters/energy_matters.shtml)
    - This also leads to the EERE homepage with even more info.
  - Also of interest is the link to student funded training.  
<http://www.iacforum.org/Default.htm>.
  - **US-EPA Energy Star Lighting Survey Program:**  
A good resource to review and evaluate.  
[http://www.energystar.gov/index.cfm?c=business.bu\\_s\\_projectkalc](http://www.energystar.gov/index.cfm?c=business.bu_s_projectkalc)

# Additional Information

- **Fluorescent lighting ballasts review:**

A good review of fluorescent lighting ballasts. The Home Page is dedicated to lighting in general.

<http://www.lightsearch.com/resources/lightguides/ballasts.html>

- **In-depth lighting information:**

<http://www.lightsearch.com/resources/lightguides/index.html>

- **Light Survey Link:**

<http://www.aa.uidaho.edu/archwebs/bldgvital/psb4c.html>

- **Pacific Gas and Electric Info on energy conservation:**

[http://www.pge.com/003\\_save\\_energy/003c\\_edu\\_train/pec/toolbox/tll/app\\_notes/index.shtml](http://www.pge.com/003_save_energy/003c_edu_train/pec/toolbox/tll/app_notes/index.shtml)

[http://www.pge.com/003\\_save\\_energy/003c\\_edu\\_train/pec/toolbox/tll/tool\\_catalog/pwr\\_energy\\_instru.shtml](http://www.pge.com/003_save_energy/003c_edu_train/pec/toolbox/tll/tool_catalog/pwr_energy_instru.shtml)